BIRD SURVEYS AT MCKINLEY BAY AND HUTCHISON BAY, NORTHWEST TERRITORIES, IN 1991.

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Beth J. Cornish
D. Lynne Dickson
H. Loney Dickson

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by
Beth J. Cornish
D. Lynne Dickson
and
H. Loney Dickson

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ABSTRACT

Aerial surveys for bird abundance and distribution were conducted in August 1991 at McKinley Bay, NWT. This bay is the site of a winter harbour for drillships and proposed location for a major year-round support base for oil and gas exploration in the Beaufort Sea. The 1991 surveys represented the continuation of a long-term monitoring study of birds in McKinley Bay and Hutchison Bay, a nearby area used as a control. The primary objectives of the 1991 surveys were to expand the set of baseline data on natural annual fluctuations in diving duck numbers, and to determine if numbers of diving ducks had changed since the initial set of surveys, from 1981 to 1985.

Survey techniques were identical to previous years. A series of east-west transects was flown across each bay and adjacent terrain. The study areas were divided into three components: bay, terrestrial, and outside.

The best survey conditions in early August of 1991 occurred on August 7. Based on the survey data from that day, the estimated population of diving ducks at McKinley Bay was 31 592 ± 7953. On average, in 1990 and 1991, significantly more diving ducks utilized McKinley Bay than in the years from 1981 to 1985 ($p<0.05$). Most of the increase in total diving duck numbers was due to significantly greater numbers of Oldsquaw ($p<0.05$).

At Hutchison Bay, there were only an estimated 11 111 ± 771 diving ducks on August 7, 1991. Again, Oldsquaw and scoters were the most common species. The 1991 results differed from all other years of surveys, in that fewer diving ducks were recorded on the bay component at Hutchison Bay than at McKinley Bay in 1991. The low counts at Hutchison Bay may reflect local changes in diving duck distribution within Hutchison Bay and adjacent bays providing similar habitat (especially Parliayut Bay). Because of the large variation in numbers of diving ducks observed at Hutchison Bay in 1990 and 1991, it is recommended that another year of aerial surveys be carried out.

As in previous years of surveys at McKinley Bay, large numbers of diving ducks were observed off Atkinson Point, at the south end of the bay and in the northeast corner near a long spit in 1991. Most divers seen in Hutchison Bay were at the west side of the bay, close to Warren Point.

Diving ducks, primarily Oldsquaw and scoter, were the most abundant bird group in the study area, but Northern Pintail, Greater White-fronted Geese, Brant, Tundra Swans, Red-throated Loons, Pacific Loons, Arctic Terns and Glaucous Gulls were also recorded frequently. Observed distribution patterns of birds are discussed with reference to habitat preferences.

RÉSUMÉ

Des relevés aériens sur la quantité d'oiseaux et leur répartition ont été menés en août 1991 à la baie McKinley (T. N.-O.). Il s'agit d'un port d'hivernage pour les navires de forage pétrolier, et ils on propose d'en faire une importante base de soutien permanente pour l'exploration du pétrole et du gaz dans la mer de Beaufort. Les relevés effectués en 1991 faisaient partie d'une étude de surveillance à long terme des oiseaux à la baie McKinley et à la baie Hutchison (région située tout près et utilisée comme aire témoin). Les objectifs principaux des relevés de 1991 étaient d'obtenir un plus grand nombre de données de référence sur la variation annuelle naturelle des effectifs de canards plongeurs et de déterminer si le nombre de canards plongeurs avait changé depuis la phase initiale des relevés, qui avait eu lieu de 1981 à 1985.

Les mêmes techniques que celles des années précédentes ont été utilisées. Une série de transects a été tracée en direction est-ouest à travers chaque baie et chaque terrain adjacent. Les régions d'étude ont été divisées en trois éléments: la baie, les terres et l'extérieur.

Les conditions d'étude ont été optimales le 7 août. Selon les données obtenues lors de cette journée, la population estimative de canards plongeurs à la baie McKinley était de 31 592 ± 7 953. En moyenne, en 1990 et 1991, un nombre beaucoup plus important de canards plongeurs ont fréquenté la baie McKinley, comparativement à la période allant de 1981 à 1985 ($p < 0,05$). Cette augmentation des effectifs de canards plongeurs était due, en grande partie, au nombre beaucoup plus important de Canards kakawis ($p < 0,05$).

À la baie Hutchison, on a estimé qu'il y avait seulement 11 111 ± 771 canards plongeurs le 7 août 1991. Une fois de plus, le Canard kakawi et les macreuses étaient les plus nombreux. Les résultats du relevé de 1991 diffèrent de ceux de toutes les autres années pour ce qui est du nombre de canards plongeurs, qui était inférieur dans l'élément baie de la baie Hutchison par rapport à la baie McKinley. Le faible nombre à la baie Hutchison peut être dû aux changements de répartition des canards plongeurs à la baie Hutchison et aux baies adjacentes qui offrent un habitat similaire (particulièrement la baie Parliayut). En raison de la variation importante du nombre de canards plongeurs observés à la baie Hutchison en 1990 et en 1991, on recommande que des relevés aériens soient menés pendant une autre année.

Une fois de plus, lors des relevés effectués à la baie McKinley en 1991, un grand nombre de canards plongeurs ont été observés près de la pointe Atkinson, à la limite sud de la baie et dans sa partie nord-est, près d'une longue langue de terre. La plupart des canards plongeurs observés à la baie Hutchison se trouvaient sur le côté ouest de la baie, près de la pointe Warren.

Dans l'aire d'étude, les canards plongeurs (particulièrement le Canard kakawi et les macreuses) étaient les oiseaux qui étaient présents en plus grand nombre. Cependant, on y a également observé le Canard pilet, l'Oie rieuse, la Bernache cravant, le Cygne siffleur, le Huart à gorge rousse, le Huart du Pacifique, la Sterne arctique et le Goéland bourgmestre. Les modèles observés de répartition des oiseaux sont traités par rapport aux préférences d'habitat.

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1.0 INTRODUCTION

McKinley Bay is a shallow protected bay along the eastern Beaufort Sea coastline in the Northwest Territories. Each year, it provides important habitat for tens of thousands of diving ducks which migrate there in summer to moult.

Since 1979, McKinley Bay has been the site of a winter harbour and support base for oil and gas exploration in the Beaufort Sea. A brief history of the industrial development of the bay, and a summary of recent industrial activity, are included in Appendix A. Major activities such as dredging operations directed towards the continued development of the bay have not occurred since 1981. Although the support base at McKinley Bay remains active, there has been very little offshore drilling in the Canadian Beaufort Sea since 1985. However, in the future, this bay may become a major year-round support base for Beaufort Sea oil and gas drilling activity.

The Canadian Wildlife Service initiated a study in 1981 to monitor the effects of industrial development and activity on bird populations using the bay. The objective of the study was to collect baseline information on natural annual fluctuations in numbers of birds, in order to detect potential changes in bird use of the bay due to harbour development. Hutchison Bay, an undeveloped bay of similar size about 45 km to the west, was also surveyed, starting in 1982, as a control. Emphasis throughout the study has been placed on moulting diving ducks, due to their abundance in both bays in midsummer. Results of the 5-year initial phase of the study were presented in an earlier report (Cornish and Dickson 1986).

Annual aerial surveys from 1981 to 1985 determined that, on the average, over 12 000 diving ducks, primarily Oldsquaw and scoters, occurred in McKinley Bay in early August each year, while an average of over 13 000 diving ducks utilized Hutchison Bay (Cornish and Dickson 1986). Numbers of scoters and Oldsquaw using McKinley Bay varied significantly in some years, although numbers of Oldsquaw were less variable than scoters (Cornish and Dickson 1986).

In order to collect a second data set for comparison with the earlier set of surveys, aerial surveys were resumed in 1990 at McKinley and Hutchison bays (Cornish et al. 1991), and repeated in 1991. The primary objective of the second set of surveys was to determine whether diving duck numbers had changed significantly in the five years since completion of the initial phase of the study. In 1990, more than twice as many diving ducks were found at both bays than on average during the five years from 1981 to 1985 (Cornish et al. 1991). This report summarizes the findings of surveys conducted in 1991, and compares the data from 1990 and 1991 to those from the first five years of surveys.

2.0 METHODS

2.1 Aerial Surveys

To allow comparisons between sets of data, the same survey methods were used during the 1991 surveys as in 1990 and from 1981 to 1985. East-west transects were flown 2 km apart (Figs. 1 and 2), in a Cessna 185 at an elevation of 30 m above ground level and at an average speed of 145 km/h. One observer on each side of the aircraft counted all birds seen within 180 m of that side, so that the total transect width was 360 m. Observations were dictated into tape recorders so that observers never had to look away from the transect. Counting bias due to differences in observer skill was reduced since observers during the 1991 surveys were the same individuals as throughout the rest of the study (with the exception of one of the observers in 1981).

It became apparent from surveys conducted in 1982 that the peak period of moult for diving ducks in the bay was the first two weeks of August (Cornish and Allen 1983), and that good survey conditions (calm sea and light cloud) were imperative for accurate survey results. Accordingly, each year surveys were conducted between August 1 and 10 on whatever days the survey conditions were expected to be suitable. The data from the survey with the best conditions, in terms of visibility of birds, were then used for the calculations.

The study area at McKinley Bay was divided into three components: the area inside McKinley Bay called the bay component, a terrestrial component, and a section of marine habitat outside McKinley Bay called the outside component (Fig. 1). The bay component encompassed saltwater areas within McKinley Bay, including exposed sandspits which were intermittently washed over by tides. Protected shallow lagoon areas, such as the small branching lagoon system east of Louth Bay and the long narrow lagoon extending about 7 km south of McKinley Bay, were considered terrestrial, as were all inland lakes. The area west of Atkinson Point, the small bay at the west end of transects 4 to 6, and the western half of transect 1 were considered the outside component. The areas of each component and the proportions surveyed are listed in Table 1. The total size of the study area was 306 km^2. The area of the bay component of the McKinley Bay study area was 108.5 km^2 and the terrestrial component was 158.5 km^2.

At Hutchison Bay, the study area was also divided into three components (Fig. 2). Again, marine areas within the bay, and sandspits intermittently washed over by tides, were considered bay component. The isolated lagoon at the east end of transect 4, the narrow, shallow channels of the bay along transects 6 and 7, and all inland lakes were included in the terrestrial component. The saltwater areas west of Warren Point and the area covered by the western half of transect 1 were considered outside component. Table 1 presents the areas of the components at Hutchison Bay and proportions surveyed.

The terms diving ducks and divers refer to ducks belonging to either Aythyinae or Merginae. References in the text to dabbling ducks or dabblers refer to surface-feeding ducks classed as Anatinae. Appendix B lists the common and scientific names of species discussed in this report.

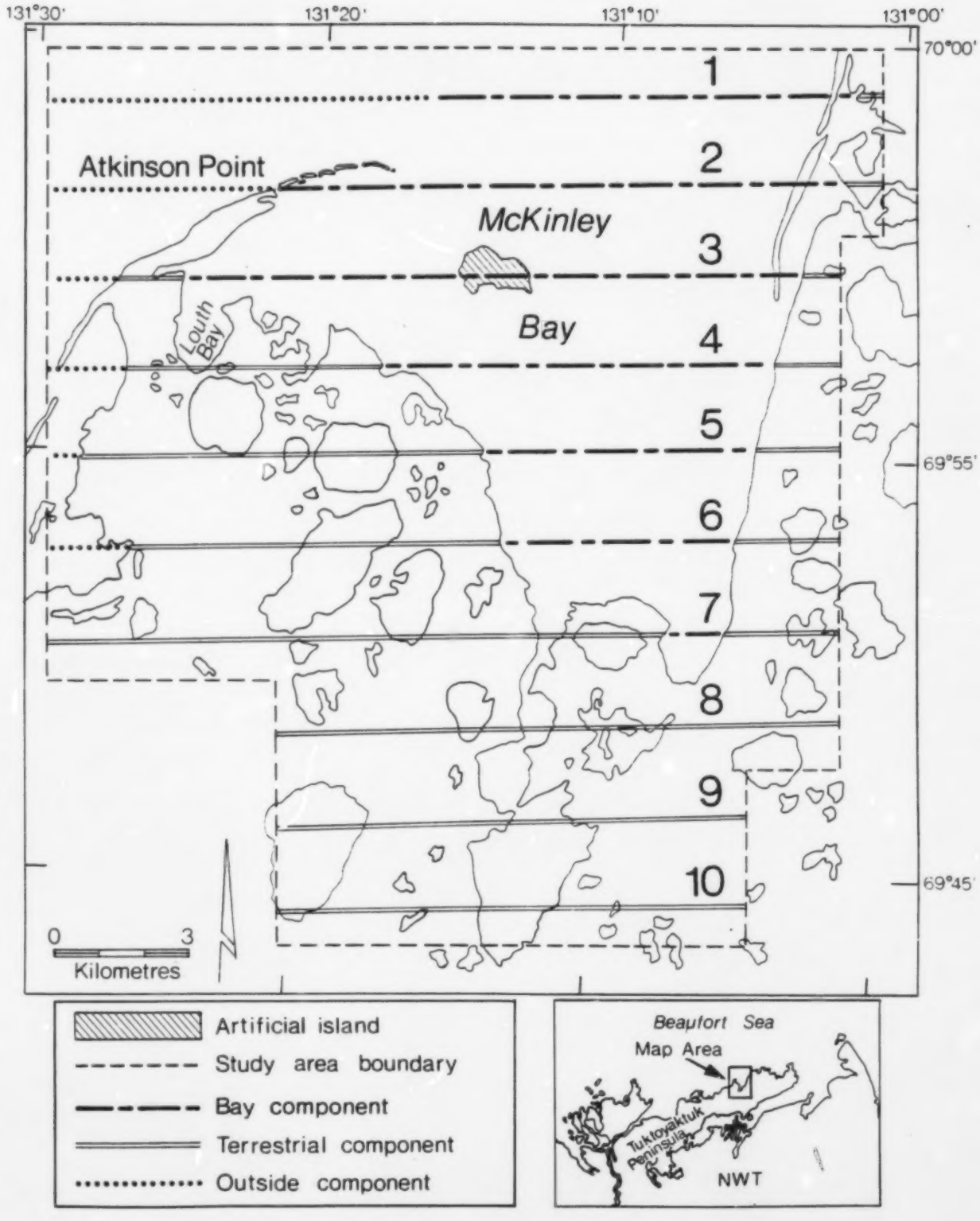

Figure 1. Aerial transects flown at McKinley Bay on August 7, 1991, showing the bay, terrestrial and outside components of the study area.

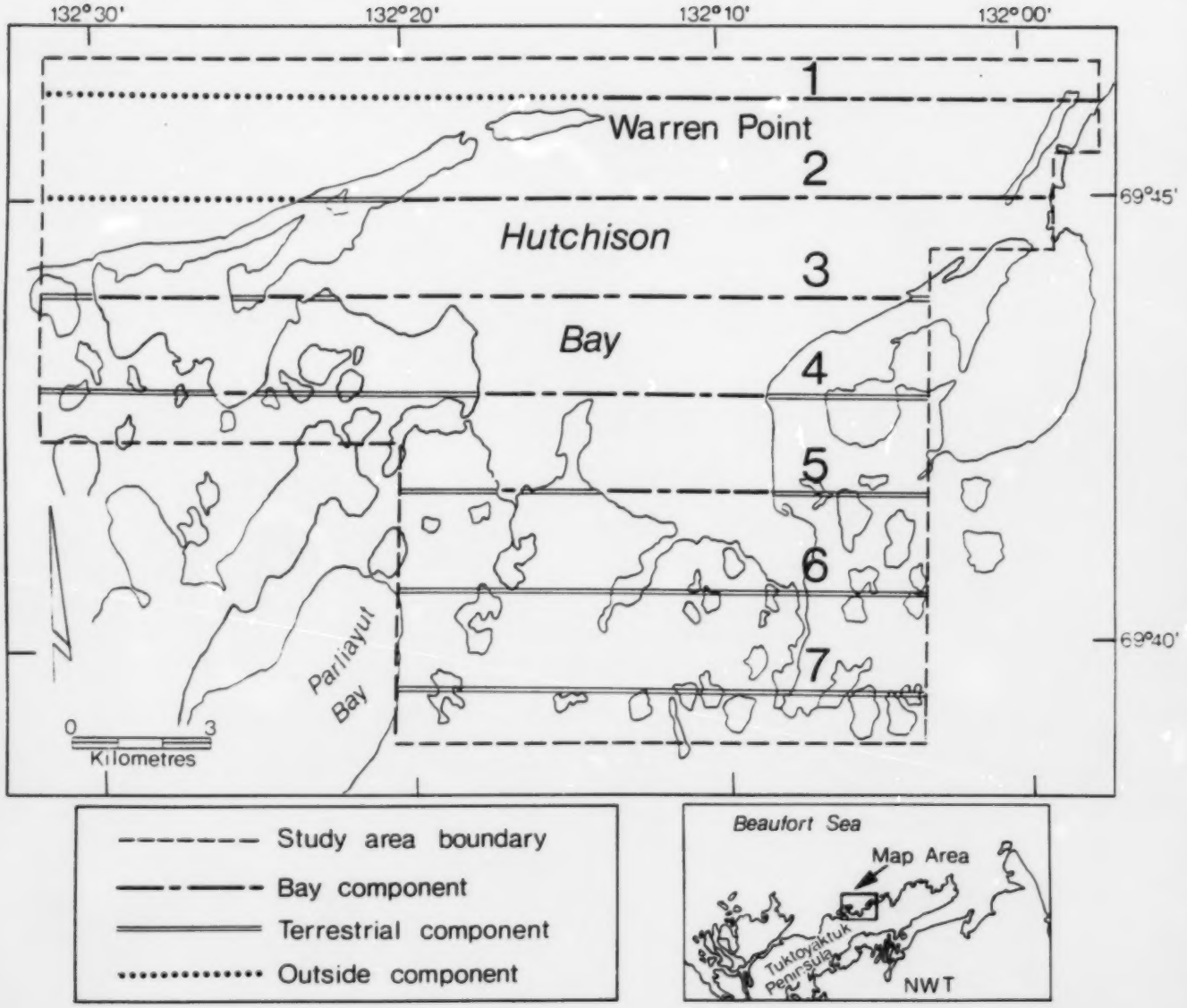

Figure 2. Aerial transects flown at Hutchison Bay on August 5 and 7, 1991, showing the bay, terrestrial and outside components of the study area.

Table 1. Aerial survey coverage of designated components of the McKinley Bay and Hutchison Bay study areas.

Component	McKinley Bay		Hutchison Bay	
	Total area (km^2)	Area surveyed (km^2)	Total area (km^2)	Area surveyed (km^2)
Bay	108.5	19.6	100.5	17.8
Terrestrial	158.5	28.3	91.0	16.3
Outside	39.0	7.1	30.5	5.8
TOTAL	306.0	55.0	222.0	39.9

2.2 Analysis of Data

At both bays, anywhere from 1 to 41% of the diving ducks were not identified to species, depending on such factors as flock size and survey conditions. To avoid underestimating species densities and population estimates on the bay component, it was necessary to include all observations of diving ducks in calculations of these parameters. Thus, for each of the major species, the adjusted number of birds was calculated by multiplying the observed proportion of that species among the identified diving ducks by the total number of diving ducks on all transects.

The mean densities for each species were then calculated by the standard ratio estimator, or the adjusted number of birds on all transects divided by the total area surveyed. Population estimates were found by multiplying the estimated mean density of birds by the total area of the study component (Table 1). The standard error of the population estimate for total diving ducks was calculated using the method by Kingsley and Smith (1980). This equation is described in earlier reports (Cornish et al. 1991).

Numbers of Oldsquaw, scoters and total divers in 1990 and 1991 were compared to values from the initial data set collected from 1981 to 1985 by calculating the t statistic (Steel and Torrie 1980). The mean for each data set was calculated using the adjusted numbers of Oldsquaw, scoters and total divers. The formula for comparison of two sample means where $n_1 \neq n_2$, is as follows:

$$t = \frac{\bar{Y}_1 - \bar{Y}_2}{S_{(\bar{Y}_1 - \bar{Y}_2)}}$$

where:

$\bar{Y}_1$ = the mean of adjusted numbers of diving ducks observed from 1981 to 1985 (for Hutchison Bay, from 1982 to 1985)

$\bar{Y}_2$ = the mean of adjusted numbers of diving ducks observed at each bay from 1990 to 1991

$$S_{(\bar{Y}_1 - \bar{Y}_2)} = \sqrt{\frac{s^2 (n_1 + n_2)}{n_1 (n_2)}}$$

and

$$s^2 = \text{pooled variance} = \frac{(n_1 - 1) S_1^2 + (n_2 - 1) S_2^2}{(n_1 - 1) + (n_2 - 1)}$$

n_1 = first sample size, which was 5 years for McKinley Bay (1981 to 1985) and 4 years for Hutchison Bay (1982 to 1985)

n_2 = second sample size, which was 2 years for both bays (1990, 1991)

For each year, only the results from the survey with the best weather and sea conditions were included for data comparisons. Significant differences were accepted at $p < 0.05$.

3.0 RESULTS

3.1 Survey Conditions

Aerial surveys in 1991 were conducted on August 5 and August 7. The first survey commenced at Hutchison Bay on August 5. During this survey, conducted between 1000 and 1115 hours, there was 90% cloud and no precipitation. However, light to moderate winds from the southwest created moderate waves with occasional whitecaps, reducing visibility of birds on the water. Overall survey conditions were rated as only fair to good.

Survey conditions for the second survey at Hutchison Bay, conducted from 1250 to 1353 on August 7, were rated as good to excellent. Skies were overcast, so there was no glare, and winds were very light, creating nearly calm sea conditions. Light intermittent rain showers occurred occasionally during the survey but were not considered to have affected visibility of birds.

Because of the wind, McKinley Bay was not surveyed on August 5. Instead, two surveys were carried out at McKinley Bay on August 7. The first survey at McKinley Bay was conducted from 1015 to 1142 hours. Sea conditions were relatively calm, with small waves but no whitecaps and only light winds from the southeast. However, skies were overcast, and occasional rain sometimes reduced visibility for surveying. During the second survey at McKinley Bay, conducted between 1530 and 1715, survey conditions were rated as good to excellent. Winds were very light, cloud cover was 100%, little precipitation was reported, and sea conditions were nearly calm. This survey was rated the best of the two surveys at McKinley Bay.

3.2 Abundance of Birds

The results of the 1991 surveys are presented in detail in Appendices C and D.

3.2.1 Bay Component

3.2.1.1 Diving Ducks

Total numbers and densities of birds on the bay components of McKinley Bay and Hutchison Bay are presented in Tables 2 and 3, respectively. Over 90% of birds at both bays were diving ducks, with the exception of the August 5 survey at Hutchison Bay when 83% were divers. Densities of divers at McKinley Bay far exceeded densities at Hutchison Bay. Comparing the results of the surveys with the best conditions, McKinley Bay had a density of 291 diving ducks/km^2, whereas there were only 111 birds/km^2 at Hutchison Bay (Tables 2 and 3).

Table 4 gives the species composition of diving ducks at each bay during the best survey in 1991. About 96% of identified diving ducks at McKinley Bay were Oldsquaw or scoters. However, these two species represented only 77% of diving ducks identified at Hutchison Bay. Also, the relative proportions of the two major species differed between bays. At McKinley Bay, there were twice as many Oldsquaw as scoters, whereas at Hutchison Bay, Oldsquaw and scoters were seen in about equal proportions (Table 4). Two species of scoters were recorded: Surf

Table 2. Number and density of birds observed on the bay component at McKinley Bay, August 7, 1991[a].

	First survey		Second survey	
Species group	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	7	0.36	23	1.17
Swans				
Geese	23	1.17	11	0.56
Dabblers	2	0.10		
Divers	2160	110.20	5707	291.17
Unidentified ducks				
Shorebirds	25	1.28		
Gulls	31	1.58	64	3.26
Terns	4	0.20	3	0.15
TOTAL BIRDS	2252	114.90	5808	296.33

[a] Area surveyed = 19.6 km^2. Blanks denote no birds seen.

Table 3. Number and density of birds observed on the bay component at Hutchison Bay in 1991[a].

	August 5		August 7	
Species group	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	15	0.84	19	1.07
Swans	6	0.34		
Geese	11	0.62	59	3.31
Dabblers	21	1.18	14	0.79
Divers	752	42.25	1968	110.56
Unidentified ducks	16	0.90		
Shorebirds	2	0.11	17	0.96
Jaegers			1	0.06
Gulls	83	4.66	65	3.65
Terns	2	0.11		
TOTAL BIRDS	908	51.01	2143	120.39

[a] Area surveyed = 17.8 km^2. Blanks denote no birds seen.

Table 4. Species composition of the diving ducks on the bay component at McKinley Bay and Hutchison Bay, August 7, 1991.

Species	McKinley Bay[a]			Hutchison Bay		
	Number observed	Percent of identified divers	Adjusted number[b]	Number observed	Percent of identified divers	Adjusted number
Oldsquaw	2179	64	3666	541	37	737
White-winged Scoters	0	0	0	5	0.3	7
Surf Scoters	158	5	266	134	9	181
Total Scoters[c]	1082	32	1820	581	40	786
Scaup sp.	30	1	51	109	7	147
Red-breasted Merganser	101	3	170	224	15	303
Identified diving ducks	3392	-	-	1455	-	-
TOTAL DIVING DUCKS	5707	-	-	1968	-	-

[a] Second survey.

[b] $\frac{\text{Number observed}}{\text{Identified diving ducks}}$ X Total diving ducks

[c] Includes unidentified scoters.

Scoters and White-winged Scoters, but the latter species was found in very low numbers, and only at Hutchison Bay.

Red-breasted Mergansers formed a major component of the diving duck population at Hutchison Bay, representing 15% of the total count. Scaup were seen in small numbers in both bays; however, the greatest numbers of scaup were seen at Hutchison Bay, where they represented 7% of diving ducks. Eiders, seen in low numbers in previous years, were not recorded during the 1991 surveys.

Forty-one percent of the divers counted at McKinley Bay could not be identified to species or genus; 26% of divers at Hutchison Bay were unidentified. Numbers of each species, extrapolated to include the unidentified diving ducks, are presented in Table 4.

Population estimates of the diving duck species, using adjusted numbers of birds on the bay component during the best survey, are given in Table 5. The estimated population of diving ducks in McKinley Bay on August 7, 1991, based on data from the second survey, was 31 592 ± 7953. At Hutchison Bay, the total population of diving ducks was estimated to be 11 111 ± 771 birds on August 7.

Comparisons of the data from the two series of aerial surveys are summarized in Figure 3, and Tables 6 and 7. At McKinley Bay, the mean number of divers observed in more recent years (1990 and 1991) was significantly greater ($p<0.05$) than the mean number observed during the earlier set of surveys, from 1981 to 1985 (Table 6). Most of the increase in total divers was due to significantly greater numbers of Oldsquaw ($p<0.05$) in 1990-91 than in the years 1981 to 1985. No significant change in total numbers of diving ducks or individual species numbers was detected at Hutchison Bay between the two series of surveys (Table 7). Adjusted numbers of each species counted in all years of surveys are presented in Appendix E.

The results of the 1991 surveys were not consistent with the 1990 results. In 1990, at both McKinley Bay and Hutchison Bay, there was a significant increase in numbers of Oldsquaw and scoters compared to results from 1981 to 1985. However, in 1991, significant increases in diving duck numbers, compared to the earlier set of surveys, were recorded only at McKinley Bay. Thus, while diving duck numbers at McKinley Bay in 1991 remained similar to numbers recorded in 1990, at Hutchison Bay, numbers of diving ducks in 1991 declined to less than half of what they were in 1990 (Fig. 3).

3.2.1.2 Other Species

Observers frequently recorded loons on the bays in 1991, in average densities of about $1/km^2$ at each bay (Tables 2 and 3). Two species of loons were identified: Red-throated Loons (88% of recorded observations) and Pacific Loons (Appendices C and D). Other species encountered on the bays, mostly near the lagoons and on the spits, were the Greater White-fronted Goose, Tundra Swan, Glaucous Gull, Northern Pintail, Arctic Tern, Parasitic Jaeger and shorebirds.

Table 5. Population estimates of the diving ducks on the bay component at McKinley Bay and Hutchison Bay on August 7, 1991.

Species	Location	Adjusted number[a]	Density (birds/km^2)	Population estimate
Oldsquaw	McKinley Bay	3666	187.04	20294
	Hutchison Bay	737	41.40	4161
Scoter sp.	McKinley Bay	1820	92.86	10075
	Hutchison Bay	786	44.16	4438
Scaup sp.	McKinley Bay	51	2.60	282
	Hutchison Bay	147	8.26	830
Red-breasted Merganser	McKinley Bay	170	8.67	941
	Hutchison Bay	303	17.02	1711
TOTAL DIVING DUCKS	McKinley Bay	5707	291.17	31592 ± 7953(S.E.)[b]
	Hutchison Bay	1968	110.56	11111 ± 771(S.E.)

[a] From Table 4.
[b] S.E. = Standard error. Not calculated for individual species since the Adjusted number includes an uneven proportion of unidentified divers on each transect.

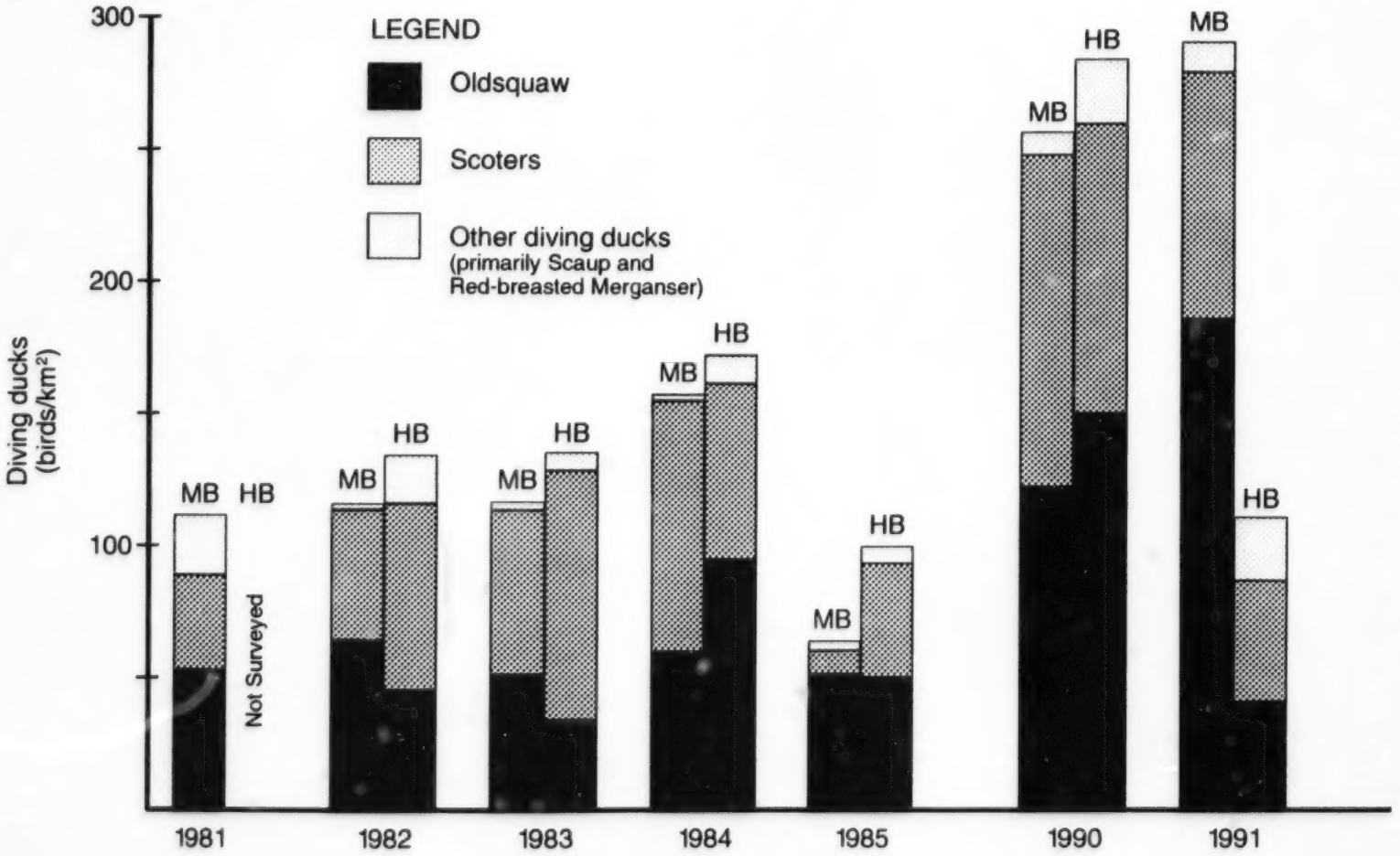

Figure 3. Densities of diving ducks on the bay component at McKinley Bay (MB) and Hutchison Bay (HB), 1981 to 1985, and 1990 to 1991.

Table 6. Comparison of adjusted numbers[a] of diving ducks on the bay component at McKinley Bay during two sets of aerial surveys, 1981 to 1985, and 1990 to 1991.

Year	Oldsquaw	Scoters	Total divers
1981	1046	705	2175
1982	1263	934	2246
1983	992	1207	2312
1984	1171	1880	3104
1985	1031	153	1258
$\bar{X}_{1981\text{-}85} \pm$ S.D.[b]	1101 ± 113	976 ± 637	2219 ± 655
1990	2397	2478	5040
1991	3666	1820	5707
$\bar{X}_{1990\text{-}91} \pm$ S.D.	3032 ± 897	2149 ± 465	5374 ± 472
Test for difference[c]	t = 5.5	t = 2.31	t = 6.05
($\bar{X}_{1981\text{-}85}$ vs. $\bar{X}_{1990\text{-}91}$)	*	ns	*

[a] Adjusted number - from Appendix E and Table 4.
[b] S.D. = Standard deviation.
[c] Compare to: $t_{0.05} = 2.571$.

* Significant difference, $p < 0.05$.
ns Not significant.

Table 7. Comparison of adjusted numbers[a] of diving ducks on the bay component at Hutchison Bay during two sets of aerial surveys, 1982 to 1985, and 1990 to 1991.

Year	Oldsquaw	Scoters	Total divers
1982	838	1246	2385
1983	617	1678	2415
1984	1717	1161	3066
1985	884	796	1801
$\bar{X}_{1982\text{-}85} \pm$ S.D.[b]	1014 ± 392	1220 ± 331	2417 ± 517
1990	2733	1901	5064
1991	732	786	1968
$\bar{X}_{1990\text{-}91} \pm$ S.D.	1733 ± 1415	1344 ± 788	3516 ± 2189
Test for difference[c]	t = 1.01	t = 0.28	t = 1.07
($\bar{X}_{1981\text{-}85}$ vs. $\bar{X}_{1990\text{-}91}$)	ns	ns	ns

[a] Adjusted number - from Appendix E and Table 4.
[b] S.D. = Standard deviation.
[c] Compare to: $t_{0.05} = 2.776$.

ns Not significant.

3.2.2 Terrestrial Component

The numbers and densities of birds recorded on the terrestrial components in 1991 are listed in Tables 8 and 9 for McKinley Bay and Hutchison Bay, respectively. As on the bay component, diving ducks were the most abundant birds recorded on the terrestrial component. At McKinley Bay, diving ducks were found in densities ranging from 27 to 44 birds/km^2 (Table 8). At Hutchison Bay, diving duck densities of 7 to 12 birds/km^2 were observed (Table 9).

The most common diving ducks on the McKinley Bay terrestrial component were Oldsquaw; about 86% of identified divers counted over the two days belonged to this species (Appendix C). At Hutchison Bay, scaup represented about 75% of identified diving ducks on the terrestrial component over the two days, while an average of 10% were Oldsquaw (Appendix D). Red-breasted Mergansers were also recorded at both bays, but were more common at McKinley Bay.

Both Red-throated and Pacific loons were recorded on the lakes and ponds, but their relative numbers varied between the two study areas. At McKinley Bay, Red-throated Loons outnumbered Pacific Loons by 3:1, whereas Pacific occurred more often than Red-throated loons at Hutchison Bay.

Two species of geese were recorded on the terrestrial component, but Greater White-fronted Geese outnumbered Brant by a ratio of at least 4:1 at both bays (Appendices C and D). The greatest density of dabbling ducks observed in 1991 was 17 birds/km^2, recorded during the second survey on August 7 at McKinley Bay (Table 8). Most dabblers were Northern Pintail, although American Wigeon were also recorded.

Tables 10 and 11 show average numbers of birds observed on the terrestrial component at McKinley Bay and Hutchison Bay, during the two series of surveys, 1990-91 and 1981-85. On average, 3 to 4 times more diving ducks were observed at both bays in 1990-1991 than from 1981 to 1985. Numbers of Oldsquaw at McKinley Bay in particular were substantially higher in 1990-1991. At Hutchison Bay, most of the increase in numbers of divers on the terrestrial component was due to higher numbers of scaup. Other species which showed increases at McKinley Bay in 1990 and 1991 include Pacific Loons, Red-throated Loons, Tundra Swans, Northern Pintail, and American Wigeon (Table 10). At Hutchison Bay, Tundra Swans and Greater White-fronted Geese were seen more frequently in 1990-1991 than in the earlier series of surveys (Table 11).

When results from both bay and terrestrial components (the two largest components of the study area) are combined, it is apparent that greater numbers of diving ducks were observed on the McKinley Bay study area in 1991 than in all other years of surveys (Appendix F). However, on the Hutchison Bay study area, overall numbers of diving ducks were lower in 1991 than in any other year except 1985 (when ice remained in the bay in early August).

Table 8. Number and density of birds observed on the terrestrial component at McKinley Bay, August 7, 1991[a].

	First survey		Second survey	
Species group	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	73	2.58	155	5.48
Swans	53	1.87	88	3.11
Geese	106	3.74	65	2.30
Dabbling ducks	244	8.62	480	16.96
Diving ducks	763	26.96	1245	43.99
Unidentified ducks	7	0.25	7	0.25
Raptors			1	0.03
Ptarmigan	4	0.14	1	0.03
Sandhill Cranes	5	0.18	10	0.35
Shorebirds	30	1.06	13	0.46
Jaegers				
Gulls	38	1.34	60	2.12
Terns	9	0.32	13	0.46
Passerines	4	0.14		
TOTAL BIRDS	1336	47.21	2138	75.55

[a] Area surveyed = 28.3 km^2. Blanks denote no birds seen.

Table 9. Number and density of birds observed on the terrestrial component at Hutchison Bay, August, 1991[a].

Species group	August 5		August 7	
	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	16	0.98	54	3.31
Swans	37	2.27	58	3.56
Geese	98	6.01	183	11.23
Dabbling ducks	70	4.29	114	6.99
Diving ducks	114	6.99	194	11.90
Unidentified ducks	10	0.61	26	1.60
Raptors				
Sandhill Cranes	4	0.24	9	0.55
Shorebirds	41	2.52	19	1.17
Jaegers	2	0.12	1	0.06
Gulls	49	3.01	34	2.09
Terns	6	0.37		
Passerines	2	0.12	3	0.18
TOTAL BIRDS	449	27.55	695	42.64

[a] Area surveyed = 16.3 km^2. Blanks denote no birds seen.

Table 10. Comparison of average numbers of birds observed on the terrestrial component at McKinley Bay during two sets of aerial surveys, 1981 to 1985, and 1990 to 1991.

	1981-1985		1990-1991	
Species	Mean	Range	Mean	Range
Pacific Loon	7.4	5- 16	23.0	14- 32
Red-throated Loon	14.0	2- 36	66.5	43- 90
Loon sp.	19.6	13- 36	19.0	5- 33
TOTAL LOONS	41.0	31- 57	108.5	62- 155
Tundra Swan	55.0	33- 73	73.0	58- 88
Brant	46.0	22-100	47.5	0- 95
Greater White-fronted Goose	24.4	0- 61	42.0	23- 61
Dark goose	47.0	0- 95	4.0	4- 4
TOTAL GEESE	117.6[a]	52-145	93.5	65- 122
Northern Pintail	106.8	40-135	358.0	184- 532
American Wigeon	12.0	3- 30	41.5	11- 72
Dabbling duck	42.4	13- 90	123.5	23- 224
TOTAL DABBLING DUCKS	161.2	78-220	523.0	480- 566
Scaup sp.	39.8	2- 86	71.5	64- 79
Eider sp.	3.8	0- 19	0.0	-
Oldsquaw	73.2	37-113	694.0	440- 948
White-winged Scoter	0.0	-	5.0	0- 10
Surf Scoter	4.8	0- 20	0.0	-
Scoter sp.	7.0	0- 20	7.0	4- 10
Red-breasted Merganser	45.6	17-100	66.0	30- 102
Diving duck	58.6	0-149	119.0	60- 178
TOTAL DIVING DUCKS	232.8	169-346	962.5	680-1245
Glaucous Gull	39.0	24- 57	53.5	47- 60
Sabine's Gull	6.8	0- 17	4.5	0- 9
TOTAL GULLS	45.8	41- 58	58.0	56- 60
Arctic Tern	15.8	1- 35	17.5	13- 22
Sandhill Crane	5.0	1- 11	6.5	3- 10

[a] Includes 1 Snow Goose.

Table 11. Comparison of average numbers of birds observed on the terrestrial component at Hutchison Bay during two sets of aerial surveys, 1982 to 1985, and 1990 to 1991.

	1982-1985		1990-1991	
Species	Mean	Range	Mean	Range
Pacific Loon	14.5	3- 25	21.0	12- 30
Red-throated Loon	14.0	0- 33	16.0	10- 22
Loon sp.	15.2	4- 33	10.5	7- 14
TOTAL LOONS	43.8	25- 69	47.5	41- 54
Tundra Swan	42.5	17- 75	78.5	58- 99
Brant	10.0	0- 40	16.0	7- 25
Greater White-fronted Goose	15.8	0- 32	61.0	26- 96
Dark Goose	16.2	0- 40	54.5	29- 80
Snow Goose	1.5	0- 6	0.0	-
TOTAL GEESE	43.5	0- 96	131.5	80-183
Northern Pintail	104.5	9-273	129.0	73-185
American Wigeon	1.5	0- 5	10.5	6- 15
Dabbling duck (Incl. 1 Mallard)	23.2	5- 59	58.5	35- 82
TOTAL DABBLING DUCKS	129.2	21-337	198.0	114-282
Scaup sp.	36.0	0-132	158.5	115-202
Eider sp.	0.0	-	0.0	-
Oldsquaw	9.8	2- 26	8.5	0- 17
White-winged Scoter	5.0	0- 20	0.0	-
Surf Scoter	3.5	0- 13	0.0	-
Scoter sp.	2.5	0- 10	4.5	3- 6
Red-breasted Merganser	8.2	0- 30	3.5	0- 7
Diving duck	13.2	0- 48	75.5	73- 78
TOTAL DIVING DUCKS	78.2	3-189	250.5	194-307
Glaucous Gull	38.5	22- 49	35.5	34- 37
Sabine's Gull	0.0	-	1.0	0- 2
TOTAL GULLS	38.5	22- 49	36.5	34- 39
Arctic Tern	13.2	3- 23	0.5	0- 1
Sandhill Crane	2.5	0- 5	6.5	4- 9

3.2.3 Outside Component

Diving ducks, geese, loons, gulls and terns were recorded, in small numbers, on the outside component (Appendices C and D). Overall densities of diving ducks were much lower on the outside component (up to 5 birds/km^2 at McKinley Bay and a maximum of 20 birds/km^2 at Hutchison Bay), than within the bays.

No geese were recorded outside of Hutchison Bay, but at McKinley Bay, a total of 55 geese (two groups of 25 dark geese and one group of 5 Brant) were found on the outside component. Red-throated Loons, and, less commonly, Pacific Loons were consistently recorded in low numbers on the outside components.

3.3 Distribution of Birds

3.3.1 McKinley Bay

The distribution of selected waterfowl groups observed during the two aerial surveys at McKinley Bay on August 7, 1991, is presented in Figures 4 and 5. Isolated groups of less than 10 diving ducks are not illustrated.

Diving Ducks

During the first survey on August 7, few large concentrations of diving ducks were observed, whereas on the second survey a large proportion were densely grouped into large flocks. Diving ducks seemed to favour three areas: north of the artificial island; near the long narrow spit at the east end of the bay; and at the south end of the bay (Figs. 4 and 5).

On the terrestrial component, diving ducks were distributed on the larger lakes south of McKinley Bay, and on the lagoon system entering the south end of the bay. Most divers identified in the terrestrial areas were Oldsquaw, scaup or mergansers; scoters were rare on the terrestrial component. A large concentration of 820 Oldsquaw was observed on a lake west of the lagoon system, on the second survey. Large flocks of divers also occurred on other lakes southwest of the bay (Figs. 4 and 5).

Red-breasted Mergansers and scaup were observed on both bay and terrestrial areas. On the bay, these species were usually observed close to shore. Bay areas most frequently utilized by these species included: a long, narrow spit at the east side of the bay; the extreme south end of the bay; the western shoreline areas; and the area south of Atkinson Point. Both species were also observed in shallow areas near shore on the outside component, most frequently in the protected bay on the west side of the study area. Red-breasted Mergansers favoured the shallow lagoon areas south of the study area. Scaup were observed on tundra ponds and lakes, and often mixed with Oldsquaw in these areas.

Other Species

Several sections of the McKinley Bay study area were utilized by geese (Figs. 4 and 5). In terms of numbers of observations, in 1991 the most important areas for geese were the following: Louth Bay; the lagoon system at the south end of

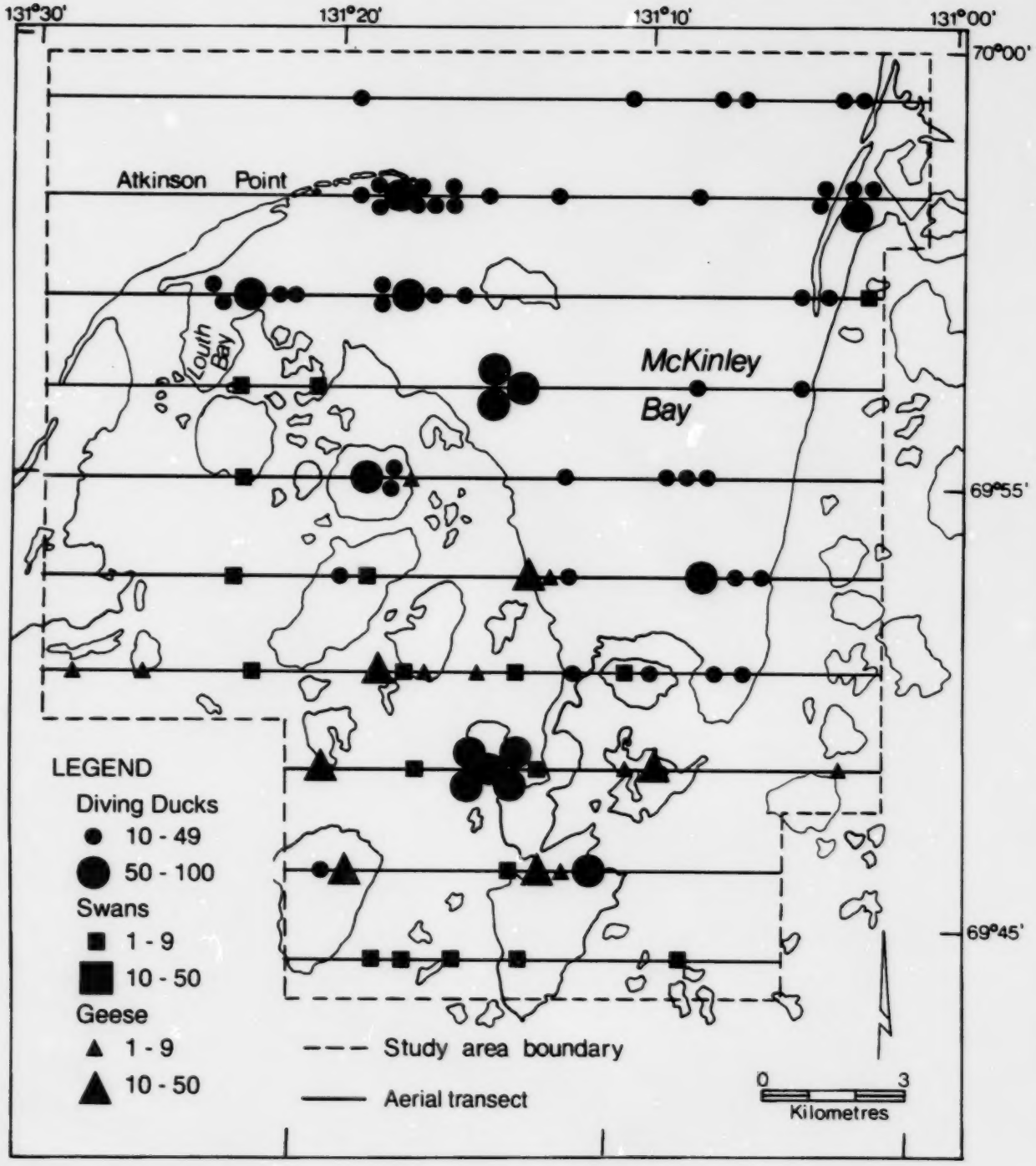

Figure 4. Distribution of waterfowl observed during the first aerial survey at McKinley Bay on August 7, 1991.

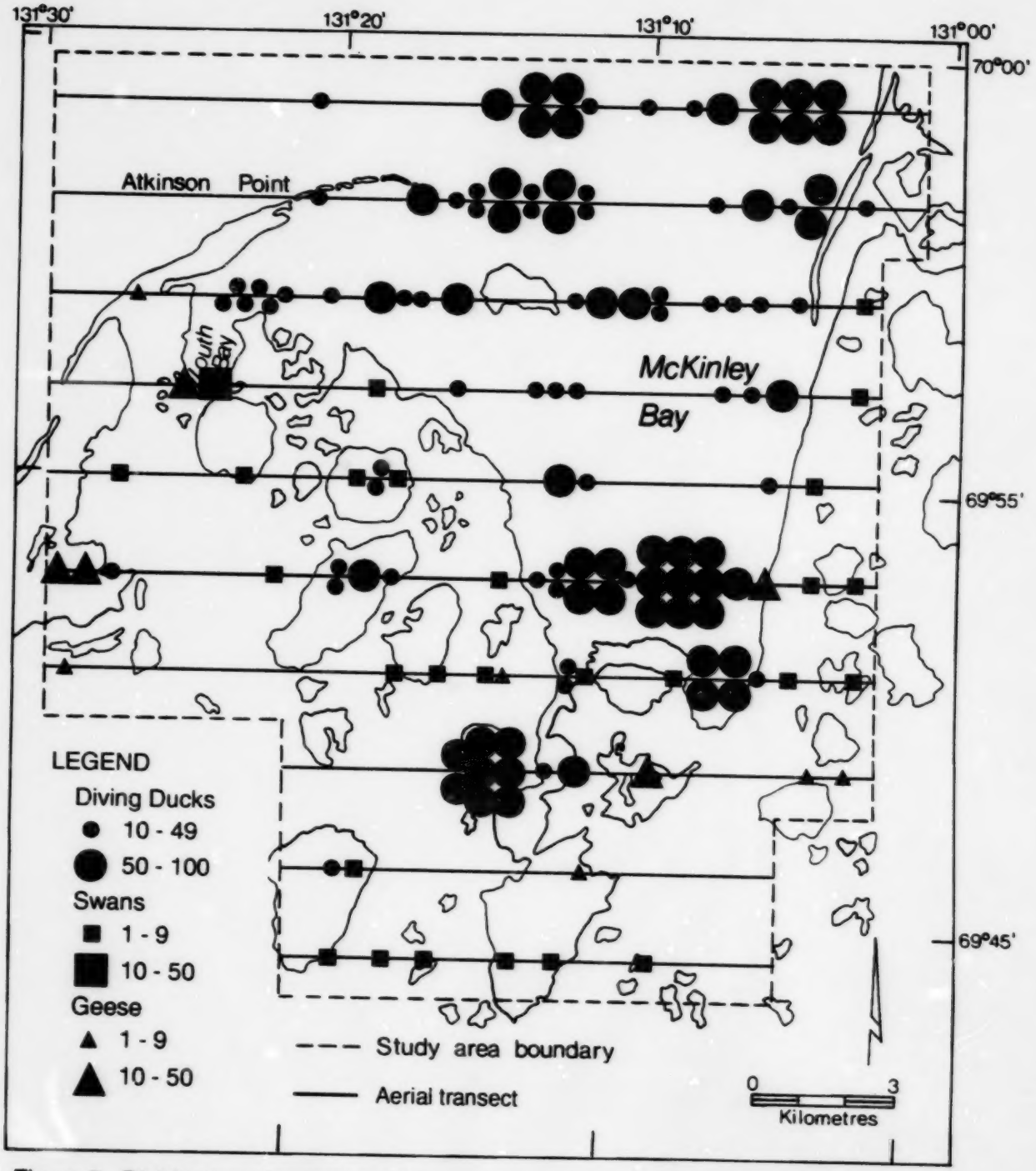

Figure 5. Distribution of waterfowl observed during the second aerial survey at McKinley Bay on August 7, 1991.

McKinley Bay; tundra lakes southwest of McKinley Bay; and the protected bay on the outside component west of McKinley Bay. Geese were also commonly observed in these areas in previous surveys from 1981 to 1985, and in 1990.

Tundra Swans were fairly evenly distributed in pairs and family groups, over the entire terrestrial component. They were seen on lakes, ponds and the shallow lagoon system. One large group consisting of 12 non-breeding adult swans was seen at the south end of Louth Bay during the second survey (Fig. 5).

Dabbling ducks, most of which were Northern Pintails, were distributed on tundra ponds and lakes throughout the study area, but were especially abundant southwest of McKinley Bay. Small numbers also occurred on lagoon channels and tidal mudflats. A flock of 55 American Wigeon was noted on Louth Bay.

Glaucous Gull were most common on Atkinson Point, on Louth Bay, and near a spit at the northeast corner of the bay. When terrestrial surveys were carried out in 1982, scattered nests of Glaucous Gulls were found in the low gravel areas on Atkinson Point, and on tundra ponds in the vicinity of Atkinson Point. In 1991, as in previous years, gulls were also encountered frequently on tundra lakes and ponds.

The greatest numbers of shorebirds were observed on tidal marshes, especially near Louth Bay and south of McKinley Bay. Sandhill Cranes were distributed throughout the terrestrial areas, and were recorded as individuals, in pairs or occasionally with young.

3.3.2 Hutchison Bay

Figures 6 and 7 show the distribution of selected waterfowl groups during aerial surveys at Hutchison Bay on August 5 and 7, respectively.

Diving Ducks

The distribution of Oldsquaw and scoters varied between the two days of surveys. On August 5, they were fairly evenly distributed, in small flocks, across most of Hutchison Bay (Fig. 6). The lowest density was in the middle of the bay. Most Oldsquaw and scoters recorded during the August 7 survey at Hutchison Bay were in the western sections of the bay, close to Warren Point, or at the south end of the bay (Fig. 7). No consistent differences in patterns of distribution of Oldsquaw and scoters within the bay were noted.

During both surveys, Red-breasted Mergansers and scaup were found in areas close to shore. Scaup favoured the western arm of the bay, southwest of Warren Point. Mergansers were observed primarily in three areas: just off the northeast tip of Warren Point, south of Warren Point (where a large flock of 190 was recorded on August 7), and also off the tip of a peninsula jutting into the southwest section of the bay.

In contrast to McKinley Bay, relatively few divers were recorded in Hutchison Bay terrestrial areas (Figs. 6 and 7). Small groups of divers occurred on lakes or lagoon areas. A flock of 75 scaup was observed on a sheltered brackish bay east

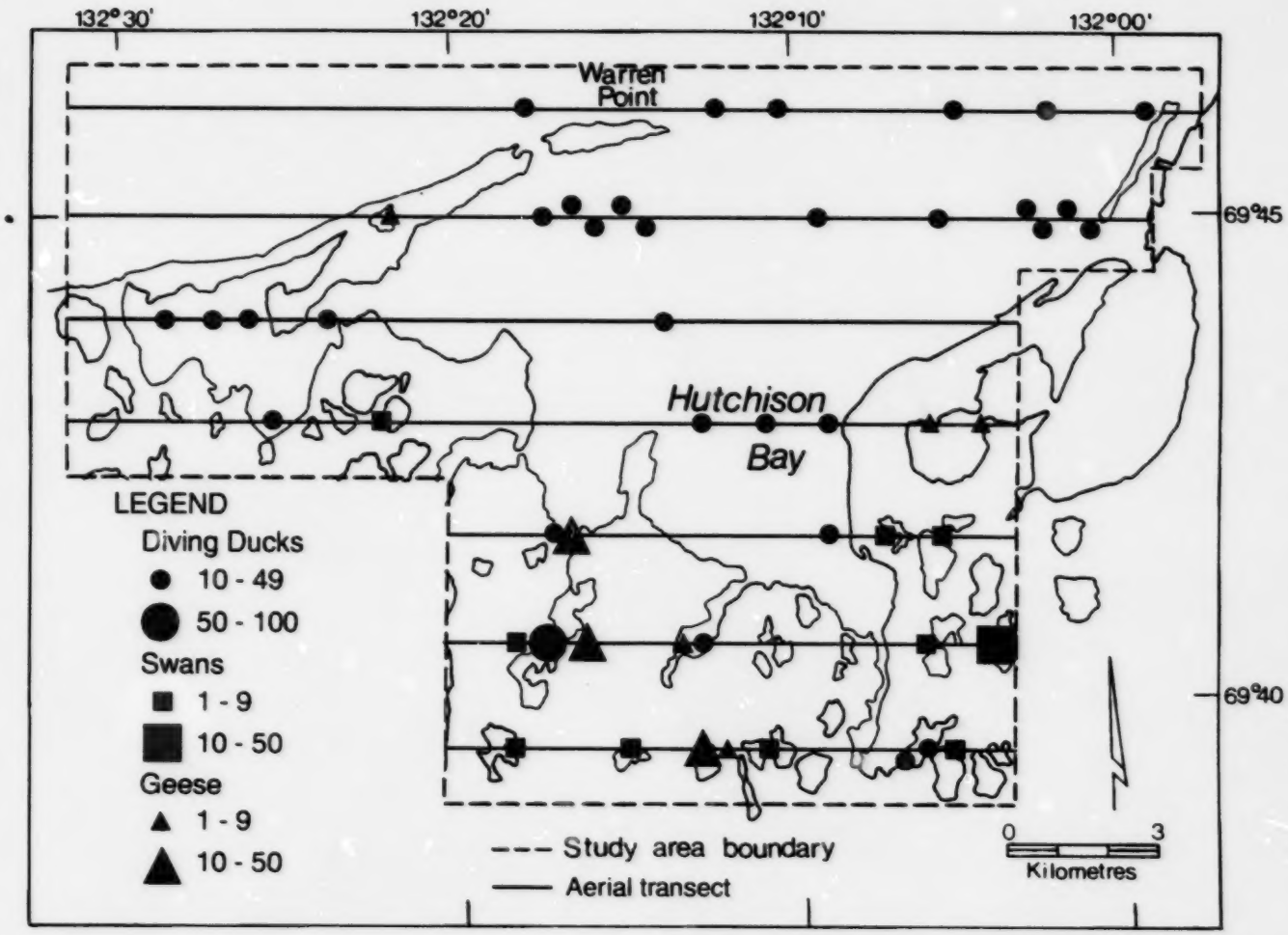

Figure 6. Distribution of waterfowl observed during the aerial survey at Hutchison Bay on August 5, 1991.

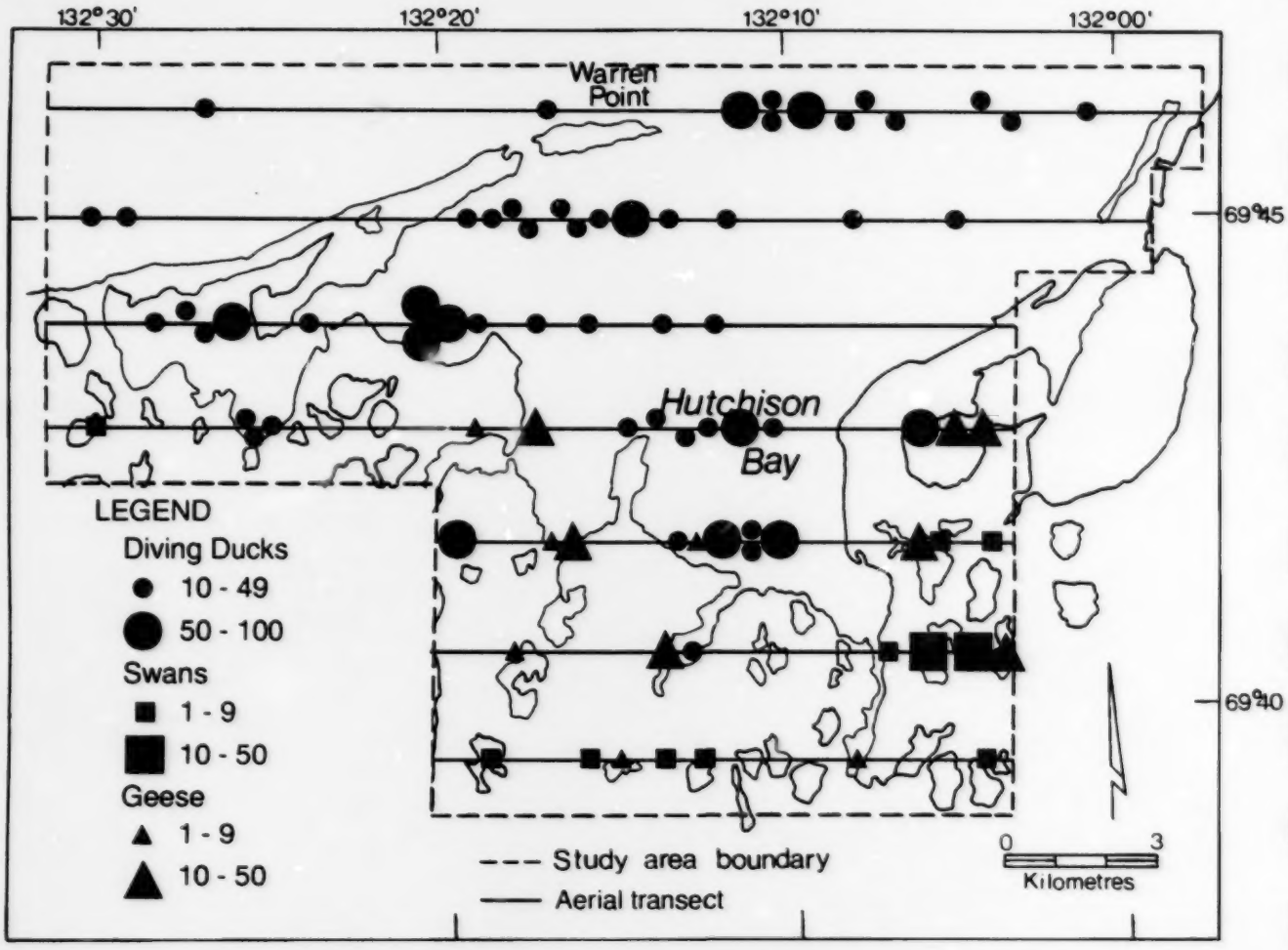

Figure 7. Distribution of waterfowl observed during the aerial survey at Hutchison Bay on August 7, 1991.

of Hutchison Bay; observers also noted 700 unidentified divers off transect in the same area.

Other Species

Geese were observed primarily on tidal flats in the more sheltered areas of Hutchison Bay, and on tundra lakes. Areas important to geese included a little bay west of a peninsula jutting into the southwest section of Hutchison Bay (a total of 50 Greater White-fronted Geese were counted there on August 7); a sheltered bay east of Hutchison Bay; several lakes, especially east of the bay; and the long narrow lagoon channels (Figs. 6 and 7).

Tundra Swans were distributed on lakes and ponds, especially at the south end of the study area, as well as on shallow lagoon channels of the bay. Two large groups of swans (22 swans in the largest group) were noted on a lake east of the bay.

Dabbling ducks occupied the ponds and shallow lakes throughout the study area, but large numbers were concentrated east of Hutchison Bay, and in the small embayment west of the peninsula jutting into the southwest section of Hutchison Bay.

Gulls were frequently encountered throughout the study area. Large numbers of gulls occurred near Warren Point spit, and on a spit in the northeast section of the bay.

Shorebirds were noted occasionally in small groups close to the shoreline. The largest numbers were near Warren Point. A group of 40 phalaropes occurred in the small bay in the southwest section of Hutchison Bay. Small numbers of Sandhill Cranes were recorded occasionally, on the tundra south of Hutchison Bay.

3.4 Flock Size

Table 12 shows the distribution of diving ducks in flocks of different sizes, based on data from the August 7, 1991 surveys at McKinley Bay and Hutchison Bay. The distribution of diving ducks in different flock sizes varied between the two bays.

At McKinley Bay, almost 50% of all divers observed were in flocks of 100 or more birds. At Hutchison Bay, most birds (68%) were in small flocks of less than 50 birds and there were no large flocks greater than 200 birds.

Among identified divers only, at McKinley Bay, there were slightly more Oldsquaw than scoters in large flocks of 100 or more birds. However, at Hutchison Bay, there was little apparent difference in the distribution of the two major diving duck species in flocks of various sizes. Over 80% of identified Oldsquaw and 75% of scoters were in small flocks of less than 50 birds at Hutchison Bay.

Table 12. Distribution of diving ducks in flocks of different sizes on the bay component at McKinley Bay and Hutchison Bay, August 7, 1991.

	Percent of total observed							
	Oldsquaw		Scoters		Unidentified divers		All divers[c]	
Flock size	MB[a]	HB[b]	MB	HB	MB	HB	MB	HB
< 10 birds	12	14	12	20	2	6	8	13
10-49 birds	43	71	31	56	8	51	27	55
50-99 birds	18	15	46	24	3	23	17	22
100-199 birds	15	0	11	0	9	19	11	10
200-399 birds	11	0	0	0	32	0	18	0
≥ 400 birds	0	0	0	0	45	0	18	0
TOTAL OBSERVED	2179	541	1082	581	2315	513	5707	1968

[a] McKinley Bay - second survey.
[b] Hutchison Bay.
[c] Includes Scaup and Red-breasted Merganser.

4.0 DISCUSSION

The results of these aerial surveys are reasonable estimators of trends in populations of diving ducks using McKinley Bay and Hutchison Bay. Survey techniques were consistent throughout all years of the study, survey conditions (cloud cover and wind speed) were similar each year, observers were currently experienced, and the same observers were used for all surveys (with the exception of one observer in 1981).

Throughout the period covered by the study (1981 to 1991), some fairly consistent patterns of diving duck abundance on the bay components of each study area are apparent. Although absolute numbers of individual species of divers using McKinley Bay and Hutchison Bay varied from year to year, the relative numbers of diving ducks using the bays appeared to be correlated. In all years of surveys except 1991, slightly greater numbers of diving ducks were recorded on the bay component at Hutchison Bay than at McKinley Bay.

Similar observations were made in another Beaufort Sea bird study. Between 1979 and 1982 at Simpson Lagoon, Oldsquaw densities showed much variation from year to year (Johnson and Richardson 1981). However, relative densities of Oldsquaw at Simpson Lagoon, compared to Oldsquaw densities at nearby Stump Island Lagoon, remained fairly constant (Troy et al. 1983, in Houghton et al. 1984).

It is unknown why there were so few diving ducks at Hutchison Bay in 1991. Lower diving duck numbers may reflect: 1) human disturbance, 2) local changes in feeding conditions for the diving ducks in Hutchison Bay and surrounding areas, 3) ice remaining in the bay when ducks arrive for the moult, or 4) a chance shift in distribution of diving ducks locally in Hutchison Bay and surrounding areas.

No known human disturbances occurred in Hutchison Bay during the period immediately prior to the 1991 surveys. Past experience at McKinley Bay indicates that it would require a considerable amount of disturbance to drive moulting diving ducks away from the bay for more than a few days (Cornish and Allen 1983; Sharp 1978). In 1982, we repeatedly surveyed McKinley Bay by zodiac boat with no apparent effect on the number of ducks moulting in the bay. In an effort to develop a technique for scaring moulting ducks away from oil spills, Sharp (1978) tried to drive ducks away from Atkinson Point, using two types of noise-makers. Although the noise-makers were effective in deterring the birds from the area initially, habituation occurred within about 3 days. Thus, human disturbance is not likely why there were so few birds in Hutchison Bay compared to McKinley Bay in 1991.

McKinley Bay and Hutchison Bay are similar in size, and only about 45 km from each other. Most natural oscillations in physical variables (such as ice dynamics and other climate-controlled variables), or biological variables (such as invertebrate prey densities) at Hutchison Bay should correspondingly have affected bird numbers at McKinley Bay. For example, large expanses of ice remained in both McKinley Bay and Hutchison Bay in early August 1985. The resulting impact on diving duck numbers, compared to previous years when there was no ice in early August, was similar at the two bays. Significantly fewer diving ducks utilized both bays in August 1985, but relative numbers of divers at the two bays remained the same.

Due to the proximity of prime moulting habitat near Hutchison Bay, there may in some years be a chance shift of moulting diving ducks from Hutchison Bay to surrounding areas. Large areas of habitat suitable for moulting diving ducks (shallow protected bays providing high prey densities, loafing sites and shelter from wind and waves; Salomonsen 1968) exist within a kilometre of the Hutchison Bay study area (Alexander et al 1988). These areas occur on both sides of Hutchison Bay: Parliayut Bay to the west, and a large sheltered embayment to the east. McKinley Bay on the other hand is more isolated, with no adjacent large areas of similar habitat suitable for moulting diving ducks.

No intensive annual systematic surveys have been carried out in the bays adjacent to Hutchison Bay. However, data from other studies suggest that both areas are heavily used by diving ducks, especially Oldsquaw (40 to 60 birds/km^2), scaup (up to 174 birds/km^2) and scoters (10 to 31 birds/km^2) (Alexander 1986, Barry et al. 1981, Barry and Barry 1982, Dickson et al. 1983; in Alexander et al. 1988).

How diving ducks are distributed within Hutchison Bay and adjacent areas may vary from year to year. In 1991, for example, large numbers of diving ducks may have utilized Parliayut Bay in early August, instead of Hutchison Bay. In order to determine if this is happening each year, the area surveyed at Hutchison Bay should be expanded to include the two adjacent bays.

In summary, the 1991 surveys provide further evidence that the population of diving ducks utilizing McKinley Bay in recent years (1990 - 1991) has increased since our earlier surveys from 1981 to 1985. However, results from surveys in 1991 at Hutchison Bay contradict the 1990 data, and are not conclusive. Because of the variability in densities of diving ducks recorded in 1990 and 1991 at Hutchison Bay, it is recommended that another year of aerial surveys be carried out.

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APPENDIX A. INDUSTRIAL ACTIVITY IN MCKINLEY BAY

Development and use of McKinley Bay as a Winter Harbour

An entrance channel and mooring basin were dredged in the northeast section of McKinley Bay in September of 1979. This was followed in 1980 by construction of a more sheltered mooring area, southwest of the original location. An artificial island was created to the north of the new location with the dredged spoils, to further protect the moored ships from storms and ice movement. In 1981, docking facilities were constructed, and the artificial island and mooring basin were expanded. In 1982 and 1983, an airstrip and accommodation for 130 people were put on the island. The island also became a storage area for fuel and materials to support the offshore drilling operation.

Use of McKinley Bay as a harbour peaked from 1982 to 1985. Since then there has been very little offshore drilling activity in the Canadian Beaufort Sea. Appendix A1 summarizes the activities associated with industrial use of McKinley Bay from 1979 to 1991.

Most of the oil spills at McKinley Bay occurred between 1979 and 1984 (Appendix A2). The two largest spills which were 500 gal in 1980 and 1100 gal in 1982 both occurred after freeze-up. There was another large spill of 7000 gal at Atkinson Point in February in 1983, but the oil did not enter the water. Since 1985, there have been only two small spills of less than 25 gal within McKinley Bay.

Two oil spill clean-up experiments were permitted in McKinley Bay under the Ocean Dumping Control Act (Seakem Group Ltd. 1991). The first experiment involved dumping about 4000 gal of crude oil under the ice in three releases from December, 1979 to April, 1980. In the second experiment which occurred in February, 1982, about 75 gal of emulsified crude oil were released under the ice.

There have been no oil spills in Hutchison Bay from 1979 to present.

Appendix A1. Level of industrial activity at McKinley Bay, 1979-1991.

Year	Dredging activity(m^3)[1]	No. of ships in January[2]	No. of ships mobilized[2]	Annual no. of person-days[3]	No. of flights	No. of offshore drilling operations[5]
1979	3 427 000	0	0	21 900	?	3-4
1980	5 860 015	16	16	48 300	?	3-4
1981	3 486 400	16	16	41 250	?	3-4
1982	42 669	19	19	45 700	?	3
1983	0	20	20	42 750	?	4
1984	0	20	20	42 750	2/d	6
1985	0	17	17	27 750	daily	5
1986	0	17	13	14 550	daily	1
1987	0	11	7	14 550	3/wk	0
1988	0	8	6	14 550	3/wk	0
1989	0	11	5	14 550	daily	1
1990	0	9	4	14 500	3/wk	0
1991[4]	0	7	6	2 850	daily	0

[1]from: Sackmann et al 1991.
[2]from: N. Vanderkooy, Canadian Marine Drilling Ltd., pers comm; John Ward, AMOCO, pers. comm; and Seakem Group Ltd. 1991.
[3]from: Seakem Group Ltd. 1991.
[4]from: N. Vanderkooy, pers. comm.
[5]from: Scott Edwards, Indian and Northern Affairs, Yellowknife, pers. comm.

Appendix A2. Oil spills reported in McKinley Bay, 1979-1991.[1]

Year	No. of oil spills	Oil spill size (gallons) <50	51 - 200	201 - 400	>400
1979	2		2		
1980	16	13	2		1
1981	3	1	1	1	
1982	10	5	2	2	1
1983	2		2		
1984	1		1		
1985	0				
1986	1	1			
1987	1	1			
1988	0				
1989	1	1			
1990	0				
1991	0				

[1]Data from NWT Spill Reports, Government of NWT.
No oil spills occurred in Hutchison Bay from 1979 to 1991.
Spill of 6995 gal of fuel oil on land at Atkinson Point on 9 February, 1983 and two spills <1 gal at McKinley Bay not included in above.

Appendix B. Scientific names of species of birds observed at McKinley Bay and Hutchison Bay.

Common name	Scientific name
Red-throated Loon	*Gavia stellata*
Pacific Loon	*Gavia pacifica*
Common Loon	*Gavia immer*
Tundra Swan	*Cygnus columbianus*
Greater White-fronted Goose	*Anser albifrons*
Brant	*Branta bernicla*
Canada Goose	*Branta canadensis*
Snow Goose	*Chen caerulescens*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
American Wigeon	*Anas americana*
Canvasback	*Aythya valisineria*
Scaup sp.	*Aythya sp.*
King Eider	*Somateria spectabilis*
Common Eider	*Somateria mollissima*
Oldsquaw	*Clangula hyemalis*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Red-breasted Merganser	*Mergus serrator*
Northern Harrier	*Circus cyaneus*
Rough-legged Hawk	*Buteo lagopus*
Gyrfalcon	*Falco rusticolus*
Willow Ptarmigan	*Lagopus lagopus*
Ptarmigan sp.	*Lagopus sp.*
Sandhill Crane	*Grus canadensis*
Whimbrel	*Numenius phaeopus*
Stilt Sandpiper	*Calidris himantopus*
Red-necked Phalarope	*Phalaropus lobatus*
Phalarope sp.	*Phalaropus sp.*
Pectoral Sandpiper	*Calidris melanotos*
Parasitic Jaeger	*Stercorarius parasiticus*
Jaeger sp.	*Stercorarius sp.*
Glaucous Gull	*Larus hyperboreus*
Sabine's Gull	*Xema sabini*
Arctic Tern	*Sterna paradisaea*
Short-eared Owl	*Asio flammeus*
Common Raven	*Corvus corax*

Appendix C1. Birds observed on the bay component of the first set of aerial surveys at McKinely Bay on August 7, 1991[a].

Species	Transect number 1	2	3	4	5	6	7	Total on all transects
Pacific Loon								
Red-throated Loon			1	1	2	1		5
Common Loon								
Loon sp.		2						2
Tundra Swan								
Brant								
Greater White-fronted Goose						23		23
Dark Goose								
Mallard								
Northern Pintail				2				2
American Wigeon								
Dabbling Duck								
Scaup sp.			4		4	9	2	19
King Eider								
Common Eider								
Eider sp.								
Oldsquaw	20	502	378	34	106	28	24	1092
White-winged Scoter		14	3					17
Surf Scoter	3	87	115		10	17	15	247
Scoter sp.	83	101	68	29	35	109	12	437
Red-breasted Merganser			18					18
Diving Duck	65	21	22	189		3	30	330
Unidentified Duck								
Northern Harrier								
Rough-legged Hawk								
Gyrfalcon								
Willow Ptarmigan								
Ptarmigan sp.								
Sandhill Crane								
Whimbrel								
Stilt Sandpiper								
Red-necked Phalarope								
Phalarope sp.								
Pectoral Sandpiper								
Shorebird				25				25
Parasitic Jaeger								
Jaeger sp.								
Glaucous Gull	4	14	4	2	4	2	1	31
Sabine's Gull								
Arctic Tern	1	2			1			4
Short-eared Owl								
Passerine								
All Species	176	743	613	282	162	192	84	2252
Km Surveyed	8.5	12.0	13.25	8.5	5.75	5.0	1.5	

[a]Blank denotes no bird seen.

Appendix C2. Birds observed on the bay component of the second set of aerial surveys at McKinley Bay on August 7, 1991[1].

Species	Transect number							Total on all transects
	1	2	3	4	5	6	7	
Pacific Loon	1					1		2
Red-throated Loon	5	3	2		3	5	2	20
Common Loon								
Loon sp.			1					1
Tundra Swan								
Brant								
Greater White-fronted Goose						11		11
Dark Goose								
Mallard								
Northern Pintail								
American Wigeon								
Dabbling Duck								
Scaup sp.		25	4			1		30
King Eider								
Common Eider								
Eider sp.								
Oldsquaw	521	732	539	181		82	124	2179
White-winged Scoter								
Surf Scoter	19	25	22	1	91			158
Scoter sp.	104	120	306	17	2	214	161	924
Red-breasted Merganser				18	14	54	15	101
Diving Duck	551	107	119	12	21	1405	100	2315
Unidentified Duck								
Northern Harrier								
Rough-legged Hawk								
Gyrfalcon								
Willow Ptarmigan								
Ptarmigan sp.								
Sandhill Crane								
Whimbrel								
Stilt Sandpiper								
Red-necked Phalarope								
Phalarope sp.								
Pectoral Sandpiper								
Shorebird								
Parasitic Jaeger								
Jaeger sp.								
Glaucous Gull	25	14	9	2	8	5	1	64
Sabine's Gull								
Arctic Tern	1					2		3
Short-eared Owl								
Passerine								
All Species	1227	1026	1002	231	139	1780	403	5808
Km Surveyed	8.5	12.0	13.25	8.5	5.75	5.0	1.5	

[1]Blank denotes no birds seen.

Appendix C3. Birds observed on the terrestrial component of the first set of aerial surveys at McKinley Bay on August 7, 1991.[3]

	Transect number										Total on all
Species	1	2	3	4	5	6	7	8	9	10	transects
Pacific Loon	2		2	2		1	2	1	3	3	16
Red-throated Loon	1		1	3	10	5	16		10	5	51
Common Loon											
Loon sp.						1	4		1		6
Tundra Swan			5	4	2	9	14	6	3	10	53
Brant								15			15
G. White-fronted Goose					8		28	20	30		86
Dark Goose								5			5
Mallard											
Northern Pintail		1	1	8	28	18	58	9	9	30	162
American Wigeon					2		5				7
Dabbling Duck	3		4	7	19	7	18	9	2	6	75
Scaup sp.					20	11	1				32
King Eider											
Common Eider											
Eider sp.											
Oldsquaw					139	1	16	450			606
White-winged Scoter											
Surf Scoter									4		4
Scoter sp.											
Red-breasted Merganser								20	85		105
Diving Duck						3	12	1			16
Unidentified Duck						7					7
Northern Harrier											
Rough-legged Hawk											
Gryfalcon											
Willow Ptarmigan									3		3
Ptarmigan sp.						1					1
Sandhill Crane			2	1			2				5
Whimbrel											
Stilt Sandpiper											
Red-necked Phalarope											
Phalarope sp.										1	1
Pectoral Sandpiper											
Shorebird				26	2	1					29
Parasitic Jaeger											
Jaeger sp.											
Glaucous Gull				6	2	4	16	2	5	3	38
Sabine's Gull											
Arctic Tern								4		5	9
Short-eared Owl											
Passerine		2								1	3
Common Raven	1										1
All Species	7	3	15	57	232	69	192	542	155	64	1336
Km Surveyed	0.25	1.0	2.25	6.75	10.75	10.25	15.5	12.0	10.0	10.0	

[3]Blank denotes no birds seen.

Appendix C4. Birds observed on the terrestrial component of the second set of aerial surveys at McKinley Bay on August 7, 1991[a].

	Transect number										Total on all
Species	1	2	3	4	5	6	7	8	9	10	transects
Pacific Loon			2	6	2	1	10	4	1	6	32
Red-throated Loon		2	2	7	8	14	24	13	17	3	90
Common Loon											
Loon sp.			5	1	7	6	4	2	2	6	33
Tundra Swan			1	16	19	16	21		3	12	88
Brant											
G. White-fronted Goose			5	14			8	34			61
Dark Goose									4		4
Mallard											
Northern Pintail				9	45	25	59		7	39	184
American Wigeon				55		2	5	8	2		72
Dabbling Duck		1	7	24	25	55	60	37	11	4	224
Scaup sp.					43	36					79
King Eider											
Common Eider											
Eider sp.											
Oldsquaw					38	29	55	820	2	4	948
White-winged Scoter											
Surf Scoter											
Scoter sp.							2		8		10
Red-breasted Merganser								30			30
Diving Duck				1	21	78		71	6	1	178
Unidentified Duck			3		1		3				7
Northern Harrier											
Rough-legged Hawk						1					1
Gyrfalcon											
Willow Ptarmigan					1						1
Ptarmigan sp.											
Sandhill Crane				2	2		6				10
Whimbrel											
Stilt Sandpiper											
Red-necked Phalarope				1							1
Phalarope sp.											
Pectoral Sandpiper											
Shorebird			2		2			8			12
Parasitic Jaeger											
Jaeger sp.											
Glaucous Gull		1		30	5	5	7	5	5	2	60
Sabine's Gull											
Arctic Tern				4	1			4	4		13
Short-eared Owl											
Passerine											
All Species	0	4	27	170	220	268	264	1036	72	77	2138
Km Surveyed	0.25	1.0	2.25	6.75	10.75	10.25	15.5	12.0	10.0	10.0	

[a]Blank denotes no birds seen.

Appendix C5. Birds observed on the outside component of the first set of aerial surveys at McKinley Bay on August 7, 1991[1].

Species	Transect number 1	2	3	4	5	6	Total on all transects
Pacific Loon							
Red-throated Loon		4		1		7	12
Common Loon							
Loon sp.							
Tundra Swan							
Brant							
Greater White-fronted Goose							
Dark Goose							
Mallard							
Northern Pintail							
American Wigeon							
Dabbling Duck							
Scaup sp.							
King Eider							
Common Eider							
Eider sp.							
Oldsquaw							
White-winged Scoter							
Surf Scoter	12						12
Scoter sp.	2						2
Red-breasted Merganser							
Diving Duck							
Unidentified Duck							
Northern Harrier							
Rough-legged Hawk							
Gyrfalcon							
Willow Ptarmigan							
Ptarmigan sp.							
Sandhill Crane							
Whimbrel							
Stilt Sandpiper							
Red-necked Phalarope							
Phalarope sp.							
Pectoral Sandpiper							
Shorebird							
Parasitic Jaeger							
Jaeger sp.							
Glaucous Gull	2	3	1	2		1	9
Sabine's Gull							
Arctic Tern		5					5
Short-eared Owl							
Passerine							
All Species	16	12	1	3	0	8	40
Km Surveyed	9.25	5.0	1.5	1.75	0.5	1.75	

[1]Blank denotes no birds seen

Appendix C6. Birds observed on the outside component of the second set of aerial surveys at McKinley Bay on August 7, 1991[3].

Species	Transect number 1	2	3	4	5	6	Total on all transects
Pacific Loon							
Red-throated Loon		3				2	5
Common Loon							
Loon sp.							
Tundra Swan							
Brant						5	5
Greater White-fronted Goose							
Dark Goose						50	50
Mallard							
Northern Pintail							
American Wigeon							
Dabbling Duck							
Scaup sp.			3				3
King Eider							
Common Eider							
Eider sp.							
Oldsquaw				2			2
White-winged Scoter							
Surf Scoter							
Scoter sp.							
Red-breasted Merganser						30	30
Diving Duck		2		2			4
Unidentified Duck							
Northern Harrier							
Rough-legged Hawk							
Gyrfalcon							
Willow Ptarmigan							
Ptarmigan sp.							
Sandhill Crane							
Whimbrel							
Stilt Sandpiper							
Red-necked Phalarope							
Phalarope sp.							
Pectoral Sandpiper							
Shorebird							
Parasitic Jaeger							
Jaeger sp.							
Glaucous Gull			1	1			2
Sabine's Gull							
Arctic Tern				2			2
Short-eared Owl							
Passerine							
All Species	0	5	4	7	0	87	103
Km Surveyed	9.25	5.0	1.5	1.75	0.5	1.75	

[3]Blank denotes no birds seen.

Appendix D1. Birds observed on the bay component of aerial surveys at Hutchison Bay on August 5, 1991[1].

Species	Transect number 1	2	3	4	5	Total on all transects
Pacific Loon		1	1		2	4
Red-throated Loon		2	2	1	1	6
Common Loon						
Loon sp.			2		3	5
Tundra Swan					6	6
Brant						
Greater White-fronted Goose					11	11
Dark Goose						
Mallard						
Northern Pintail				2	2	4
American Wigeon				2		2
Dabbling Duck					15	15
Scaup sp.		5	55			60
King Eider						
Common Eider						
Eider sp.						
Oldsquaw	47	97	14	100	17	275
White-winged Scoter		1				1
Surf Scoter	46	50	21	9		126
Scoter sp.	54	61	1	2	5	123
Red-breasted Merganser	28					28
Diving Duck	30	102	4		3	139
Unidentified Duck			15		1	16
Northern Harrier						
Rough-legged Hawk						
Gyrfalcon						
Willow Ptarmigan						
Ptarmigan sp.						
Sandhill Crane						
Whimbrel						
Stilt Sandpiper						
Red-necked Phalarope						
Phalarope sp.						
Pectoral Sandpiper						
Shorebird					2	2
Parasitic Jaeger						
Jaeger sp.						
Glaucous Gull	29	6	34	10	4	83
Sabine's Gull						
Arctic Tern	1	1				2
Short-eared Owl						
Passerine						
All Species	235	326	149	126	72	908
Km Surveyed	10.5	13.5	15.5	6.5	3.5	

[1]Blank denotes no birds seen.

Appendix D2. Birds observed on the bay component of aerial surveys at Hutchison Bay on August 7, 1991*.

Species	Transect number 1	2	3	4	5	Total on all transects
Pacific Loon	1					1
Red-throated Loon		4	2	3	5	14
Common Loon						
Loon sp.			3		1	4
Tundra Swan						
Brant						
Greater White-fronted Goose				23	34	57
Dark Goose				2		2
Mallard						
Northern Pintail					2	2
American Wigeon						
Dabbling Duck					12	12
Scaup sp.			30	78	1	109
King Eider						
Common Eider						
Eider sp.						
Oldsquaw	209	120	30	59	123	541
White-winged Scoter	1		4			5
Surf Scoter	36	57	4	35	2	134
Scoter sp.	150	218	54	16	4	442
Red-breasted Merganser			202	22		224
Diving Duck		6	293	112	102	513
Unidentified Duck						
Northern Harrier						
Rough-legged Hawk						
Gyrfalcon						
Willow Ptarmigan						
Ptarmigan sp.						
Sandhill Crane						
Whimbrel						
Stilt Sandpiper						
Red-necked Phalarope						
Phalarope sp.						
Pectoral Sandpiper						
Shorebird		17				17
Parasitic Jaeger					1	1
Jaeger sp.						
Glaucous Gull	3	5	42	6	9	65
Sabine's Gull						
Arctic Tern						
Short-eared Owl						
Passerine						
All Species	400	427	664	356	296	2143
Km Surveyed	10.5	13.5	15.5	6.5	3.5	

*Blank denotes no birds seen.

Appendix D3. Birds observed on the terrestrial component of aerial surveys at Hutchison Bay on August 5, 1991[1].

Species	Transect number						Total on all transects
	2	3	4	5	6	7	
Pacific Loon			4	1		3	8
Red-throated Loon				3	1	2	6
Common Loon							
Loon sp.					2		2
Tundra Swan			2	6	16	13	37
Brant					30		30
Greater White-fronted Goose	4		4		2	55	65
Dark Goose			3				3
Mallard							
Northern Pintail	15		1	22	8	2	48
American Wigeon							
Dabbling Duck			4		14	4	22
Scaup sp.					25		25
King Eider							
Common Eider							
Eider sp.							
Oldsquaw		4				14	18
White-winged Scoter							
Surf Scoter							
Scoter sp.			9			2	11
Red-breasted Merganser					9		9
Diving Duck					46	5	51
Unidentified Duck					10		10
Northern Harrier							
Rough-legged Hawk							
Gyrfalcon							
Willow Ptarmigan							
Ptarmigan sp.							
Sandhill Crane		2				2	4
Whimbrel							
Stilt Sandpiper							
Red-necked Phalarope				40			40
Phalarope sp.							
Pectoral Sandpiper							
Shorebird					1		1
Parasitic Jaeger						2	2
Jaeger sp.							
Glaucous Gull	1	21	1	24	2		49
Sabine's Gull							
Arctic Tern	1			1		4	6
Short-eared Owl							
Passerine							
Common Raven						2	2
All Species	21	27	28	97	166	110	449
Km Surveyed	1.75	2.5	11.5	7.5	11.0	11.0	

[1]Blank denotes no birds seen.

Appendix D4. Birds observed on the terrestrial component of aerial surveys at Hutchison Bay on August 7, 1991*.

Species	Transect number 2	3	4	5	6	7	Total on all transects
Pacific Loon		1	5	1	6	17	30
Red-throated Loon	4			5	1		10
Common Loon							
Loon sp.			3	4	2	5	14
Tundra Swan		2	2	3	39	12	58
Brant			7				7
Greater White-fronted Goose					83	13	96
Dark Goose			65	15			80
Mallard							
Northern Pintail		1	7	30	9	26	73
American Wigeon			6				6
Dabbling Duck			25		8	2	35
Scaup sp.			75		40		115
King Eider							
Common Eider							
Eider sp.							
Oldsquaw							
White-winged Scoter							
Surf Scoter							
Scoter sp.			4		2		6
Red-breasted Merganser							
Diving Duck				65	8		73
Unidentified Duck				1	25		26
Northern Harrier							
Rough-legged Hawk							
Gyrfalcon							
Willow Ptarmigan							
Ptarmigan sp.							
Sandhill Crane						9	9
Whimbrel							
Stilt Sandpiper							
Red-necked Phalarope							
Phalarope sp.							
Pectoral Sandpiper							
Shorebird				1	17	1	19
Parasite Jaeger			1				1
Jaeger sp.							
Glaucous Gull	2	1		19	5	7	34
Sabine's Gull							
Arctic Tern							
Short-eared Owl							
Passerine			1				1
Common Raven						2	2
All Species	6	5	201	144	245	94	695
Km Surveyed	1.75	2.5	11.5	7.5	11.0	11.0	

Appendix D5. Birds observed on the outside component of aerial surveys at Hutchison Bay on August 5, 1991[1].

Species	Transect number 1	Transect number 2	Total on all transects
Pacific Loon			
Red-throated Loon	1	1	2
Common Loon			
Loon sp.			
Tundra Swan			
Brant			
Greater White-fronted Goose			
Dark Goose			
Mallard			
Northern Pintail			
American Wigeon			
Dabbling Duck			
Scaup sp.		6	6
King Eider			
Common Eider			
Eider sp.			
Oldsquaw			
White-winged Scoter			
Surf Scoter	15		15
Scoter sp.			
Red-breasted Merganser			
Diving Duck			
Unidentified Duck			
Northern Harrier			
Rough-legged Hawk			
Gyrfalcon			
Willow Ptarmigan			
Ptarmigan sp.			
Sandhill Crane			
Whimbrel			
Stilt Sandpiper			
Red-necked Phalarope			
Phalarope sp.			
Pectoral Sandpiper			
Shorebird			
Parasitic Jaeger			
Jaeger sp.			
Glaucous Gull	3		3
Sabine's Gull			
Arctic Tern			
Short-eared Owl			
Passerine			
All Species	19	7	26
Km Surveyed	11.0	5.25	

[1]Blank denotes no birds seen.

Appendix D6. Birds observed on the outside component of aerial surveys at Hutchison Bay on August 7, 1991[1].

Species	Transect number 1	2	Total on all transects
Pacific Loon		2	2
Red-throated Loon			
Common Loon			
Loon sp.			
Tundra Swan			
Brant			
Greater White-fronted Goose			
Dark Goose			
Mallard			
Northern Pintail			
American Wigeon			
Dabbling Duck			
Scaup sp.			
King Eider			
Common Eider			
Eider sp.			
Oldsquaw	12		12
White-winged Scoter			
Surf Scoter	8		8
Scoter sp.	26	69	95
Red-breasted Merganser			
Diving Duck	1	1	2
Unidentified Duck			
Northern Harrier			
Rough-legged Hawk			
Gyrfalcon			
Willow Ptarmigan			
Ptarmigan sp.			
Sandhill Crane			
Whimbrel			
Stilt Sandpiper			
Red-necked Phalarope			
Phalarope sp.			
Pectoral Sandpiper			
Shorebird			
Parasitic Jaeger			
Jaeger sp.			
Glaucous Gull		1	1
Sabine's Gull			
Arctic Tern			
Short-eared Owl			
Passerine			
All Species	47	73	120
Km Surveyed	11.0	5.25	

[1]Blank denotes no birds seen.

Appendix E1. Adjusted number of each species of diver seen on the bay component at McKinley Bay each year based on the species composition of the identified divers.

Year	Oldsquaw			Scoter			Scaup			Red-breasted Merganser			Eider			Identified divers		Unidentified divers	Total divers
	No.	%	Adj. no.	No.	%	Adj. no.	No.	%	Adj. no.	No.	%	Adj. no.	No.	%	Adj. no.	Total	%		
1981	910	48	1046	613	32	705	369	20	424	0	0	0	0	0	0	1892	87	283	2175
1982	1063	56	1263	785	41	934	34	2	40	8	<1	9	0	0	0	1890	84	356	2246
1983	814	43	992	990	52	1207	93	5	113	0	0	0	0	0	0	1897	82	415	2312
1984	913	38	1171	1466	61	1880	20	<1	26	20	<1	26	1	<1	1	2420	77	684	3104
1985	996	82	1031	148	12	153	70	6	72	0	0	0	1	<1	1	1215	96	43	1258
1990	1713	48	2397	1771	49	2478	87	2	122	31	1	43	0	0	0	3602	71	1438	5040
1991	2179	64	3666	1082	32	1820	30	1	51	101	3	170	0	0	0	3392	59	2315	5707

Appendix E2. Adjusted number of each species of diver seen on the bay component at Hutchison Bay each year based on the species composition of the identified divers.

	Oldsquaw			Scoter			Scaup			Red-breasted Merganser			Eider			Identified divers			
Year	No.	%	Adj. no.	No.	%	Adj. no.	No.	%	Adj. no.	No.	%	Adj. no.	No.	%	Adj. no.	Total	%	Unidentified divers	Total divers
1981	not surveyed																		
1982	778	35	338	1156	52	1246	122	5	132	157	7	169	0	0	0	2213	93	172	2385
1983	578	26	617	1571	69	1678	99	4	106	13	<1	14	0	0	0	2261	94	154	2415
1984	1488	56	1717	1006	38	1161	159	6	183	4	<1	5	0	0	0	2657	87	409	3066
1985	872	49	884	785	44	796	102	6	104	6	<1	6	11	1	11	1776	99	25	1801
1990	2436	54	2733	1694	38	1901	252	6	283	131	3	147	0	0	0	4513	89	551	5064
1991	541	37	732	581	40	786	109	7	147	224	15	303	0	0	0	1455	74	513	1968

Appendix F1. Number of birds seen at McKinley Bay from 1990-91 compared to 1981-85 (bay and terrestrial components combined).*

Species	1981	1982	1983	1984	1985	1990	1991	$\bar{X}_{1981-85}$	±SD	$\bar{X}_{1990-91}$	±SD
Pacific Loon	9		24	10	9	25	34	10	9	30	6
Red-throated Loon	4	2	18	42	56	80	110	24	24	95	21
Loon sp.	49	44	29	13	11	11	34	29	17	22	16
Total Loons	62	46	71	65	76	116	178	64	11	147	44
Tundra Swan	33	73	37	71	61	58	88	55	19	73	21
Brant	97	100	22	47	38	95		61	36	48	67
G. White-fronted Goose			30	61	31	23	72	24	26	48	35
Dark Goose	95	45		47	65	4	4	50	34	4	0
Snow Goose	1							<1	<1		
Total Geese	193	145	52	155	134	122	76	136	52	99	33
Northern Pintail	127	130	40	110	158	536	184	113	44	360	249
American Wigeon	3	30	6	7	15	11	72	12	11	42	43
Dabbling Duck	93	43	33	33	13	23	224	43	30	124	142
Total Dabblers	223	203	79	150	186	570	480	168	57	525	64
Scaup sp.	391	120	95	71	87	151	109	153	134	130	30
Eider sp.	19			1	1			4	8		
Oldsquaw	1023	1120	877	950	1092	2153	3127	1012	100	2640	689
White-winged Scoter	338	83	69	46	8	370		109	131	185	262
Surf Scoter	171	382	753	907	65	673	158	456	364	416	364
Scoter sp.	121	340	168	515	95	742	934	248	177	838	136
Total Scoters	630	805	990	1468	168	1785	1092	812	477	1438	490
Red-breasted Merganser	25	25	100	60	46	133	131	51	31	132	1
Diving Duck	410	356	416	833	57	1498	2493	414	277	1996	704
Total Divers	2498	2426	2478	3383	1451	5720	6952	2447	684	6336	871
Sandhill Crane	11	1	6	2	5	3	10	5	4	6	5
Shorebirds	142	152	203	62	56	176	13	123	63	94	115

Appendix F1. Continued.

Species	1981	1982	1983	1984	1985	1990	1991	$\bar{X}_{1981-85}$	±SD	$\bar{X}_{1990-91}$	±SD
Glaucous Gull	83	81	101	77	36	95	124	76	24	110	20
Sabine's Gull	8		4	9	17	9		8	6	4	6
Total Gulls	91	81	105	86	53	104	124	83	19	114	14
Arctic Tern	97	8	39	70	8	28	16	44	39	22	8
Date of survey	Aug 10	Aug 10	Aug 5	Aug 3	Aug 4	Aug 5	Aug 7				

*Blanks denote no birds seen

Appendix F2. Number of birds seen at Hutchison Bay from 1990-91 compared to 1982-85 (bay and terrestrial components combined).[a]

Species	1982	1983	1984	1985	1990	1991	$\bar{X}_{1982-85}$	±SD	$\bar{X}_{1990-91}$	±SD
Pacific Loon	4	11	25	22	15	31	16	10	23	11
Red-throated Loon	2	17	24	51	48	24	24	20	36	17
Loon sp.	54	14	17	18	8	18	26	19	13	7
Total Loons	60	42	66	91	71	73	65	20	72	1
Tundra Swan	35	17	75	48	100	58	44	24	79	30
Brant	78		60	65	89	7	51	35	48	60
G. White-fronted Goose	32			31	26	153	16	18	90	90
Dark Goose		35	61	25	33	82	30	25	58	35
Snow Goose	6		8	24			10	10		
Total Geese	116	35	129	145	148	242	106	49	195	66
Northern Paintail	61	9	92	273	210	75	109	115	142	95
American Wigeon	1			5	16	6	2	2	11	7
Dabbling Duck	5	12	26	59	85	47	26	24	66	27
Total Dabblers	67	21	118	337	311	128	136	140	220	129
Scaup sp.	122	231	159	114	454	224	156	53	339	163
Eider sp.				11			3	6		
Oldsquaw	780	586	1491	898	2453	541	939	390	1497	1352
White-winged Scoter	4	59	214	84	55	5	90	89	30	35
Surf Scoter	904	908	632	443	1005	134	722	226	570	616
Scoter sp.	271	605	160	278	637	448	328	192	542	134
Total Scoters	1179	1572	1006	805	1697	587	1140	326	1142	785
Red-breasted Merganser	160	13	4	36	138	224	53	72	181	61
Diving Duck	177	202	409	25	629	586	203	158	608	30
Total Divers	2418	2604	3069	1889	5371	2162	2495	488	3766	2269
Sandhill Crane	5	5			4	9	2	3	6	4
Shorebirds	14	46	27	82	79	36	42	30	58	30
Glaucous Gull	85	71	49	56	54	99	62	16	76	32
Sabine's Gull					2				1	1
Total Gulls	85	71	49	56	56	99	65	16	78	30
Arctic Tern	4	24	19	11	1	0	14	9	<1	<1
Date of survey	Aug 10	Aug 5	Aug 3	Aug 4	Aug 5	Aug 7				

[a]Blanks denote no birds seen